SUPPLEMENT.

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RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Royal School of Mines.

Mr. WARINGTON SMYTH'S LECTURES ON MINING.

Lecture XXIX.—Most of the methods of timbering they had considered were extremely expensive, and if their cost could be reduced it was much to be desired. He had already drawn attention to the fact that timber was more apt to be destroyed in places where the ventilation was bad than where it was well cared for, and a strong current of atmospheric air kept up. In addition to other more vital reasons, it is, therefore, necessary, on account of the increased durability of the timber, to pay attention to ventilation. It is noticeable that where timber has water constantly running down over it, it lasts better than elsewhere. For this reason, in timbered shafts, which are very expensive on account of the large size of the timber that has to be employed, arrangements are sometimes made to throw upon the wood a constant shower of water. When timber is applied to levels in which the lining is to remain permanently, it is desirable if possible to replace the timber by some more durable material. Suppose the case of a lode in soft material, in which it has been found necessary to run the level in the country on the hanging side of the lode, and the whole of the lode has been removed, the hanging wall will soon begin to break away, and there would no longer be any secure foundation for masonry, so that it might from this cause be preferable to put in timber. But supposing the level to be driven as a permanent way on the footwall side, it may be secured in preference by arching, steining, or stilling. It is not in all districts that they have the choice, as suitable stone cannot always conveniently be obtained, and then timber will remain a heavy item in the cost-sheet of a mine. If a mine is to be worked by permanent levels it is obviously a good thing to secure such levels in some durable manner. An adit level which is to be kept open for a great length of time, to unwater a mine or a district, should be secured by some more permanent material than timber. Moreover, timber is apt to break, and then down comes a run of ground, and so fills up the adit that it may take weeks or months to clear it away; meanwhile, the mine is hampered, and operations hindered. The work of spilling through broken ground of this kind is always a laborious and difficult operation. It frequently happens, therefore, in countries like this, where there is a heavy rain fall, and especially where the wet season is short but severe, that it is necessary to protect and secure the adits in the best way, and by masonry rather than by timber. In that case it is a question what stone should be employed. There may be stones obtainable in the workings, or from quarries at the surface; and occasionally stone may be obtainable from the walls of the lode, which, of course, is a great advantage. Care must be taken, however, as there are many kinds of rock which are not suitable for underground walling, such, for instance, as break irregularly or angularly. Rock containing iron pyrites is objectionable, as it imbibes oxygen greedily, and then becomes very crumbly. Those rocks are most useful which have a tendency to break into slabs or square blocks. Sandstone or freestone is extremely valuable for this purpose, and is found in many of the coal fields. It fractures easily in a given direction, and has a tendency to separate in parallel planes, a quality often due to the presence of mica. Fortunately for English mining, these valuable stones occur plentifully in the lower coal measures, and excellent work done with stone of this kind may be seen in the Forest of Dean, as well as in Yorkshire, Durham, and Northumberland. In Yorkshire it is not unusual to bargain with the men to drive the level, and wall it as they go on with stone. Sometimes it occurs interstratified with the workable coal, but it is most apt to occur in large and valuable masses, of excellent quality, below the chief seams of the coal measures. It should be remarked that as it would be too expensive to chisel the stone, these rocks, when of a slabby character, are the most useful. These stones, and also limestones from the lower coal measures, are exceedingly durable, for colliery shafts especially. Here and there in Yorkshire and Derbyshire they are found capable of withstanding great weights, but in metallic mines the rocks used are often of a crystalline character, like gneiss. Granite is more rarely employed, but there is a remarkable instance of its use in the deep and extensive Tresavean Copper Mine. Schistose rocks, hornblende, and mica schist are employed in Saxony and Scandinavia. In Staffordshire, where there is a great absence of rock, Nature provides another material, in the abundance of clay suitable for making brick, and brick is one of the most convenient and suitable means of securing levels and shafts, and may be used upon a small or a very large scale. There are but few cases in which artificial roofing does not come into play. When the rocks are greatly metamorphosed, and brought into a crystalline condition, as in Scandinavia, roofing may not be needed in adit levels, but even there, if men have to travel through them, some contrivance is required for a flooring, to keep them out of the water, and a channel is sometimes made by an arch 15 in. by 9 in., the roadway being established on the top of the arch. Another similar mode is to employ breadths of masonry as girdles, at small distances asunder, and in some classes of rock, which is liable to split only in long pieces, it is a very serviceable method. Another mode of employing stone is that found in the old lead mines in Derbyshire, where a flaggy kind of limestone occurs in the walls of the lode, in which they cut a little hitch on one side, and then fix on it a slab of stone to rest on the other side, and is thus made capable of supporting great weights. In Spain, in many old workings this plan is beautifully carried out, hitches being cut at the sides, and two large stones set to lean against each other, like a pointed arch. Another method sometimes used is that found in the entrance to the Great Pyramid and other works of the ancient Egyptians, which is the nearest approximation to anything like an arch found at those early dates. Flat stones are laid upon each other on opposite sides of the opening, each projecting over the one below it, until at last one long slab goes right across and completes the work. This rude sort of arching, if it may so be called, is often used in odd places (but not as a system) in metalliferous mines, where there is a good deal of dry walling of various kinds carried out. With regard to dry walling, it is important to get a stone of a sufficiently jaggy form, and then it may be put in very cheap indeed. And, in the same way, when mortar is employed it is even more necessary to see that it is composed of the right material. The mining engineer, if he keeps his eyes open, may often obtain for himself kinds of lime which will set rapidly in wet places, partaking of the character of hydraulic lime, or a cement. These hydraulic limes, if there should be deposits near, are in themselves an article of commerce of great value. The materials of which these hydraulic cements or mortars are formed of, generally speaking, carbonates of lime, with 25 per cent. of other materials, chiefly silicate of alumina. The London clay, in the lias beds at Lyme Regis, and the deposits of Aberthaw, in South Wales, produce excellent hydraulic lime. If, indeed, the mining engineer perceives a dark-grey clayey limestone of considerable hardness, and frequently with a fœtid smell, when the rock has a strong tendency to the nodular form, he may expect to find that it possesses the quality of making a mortar which will set in water. A substance of this sort, largely employed in Holland, is a greenish yellow pumiceous conglomerate, called trass, so soft in the beds that it may be dug out with a spade. In Italy, a substance called puzzolana, also of a pumiceous character, is used. It is noticeable that in the upper part of the carboniferous limestone there are dark grey beds of material which may be employed for the purpose of building under water: and the mining engineer, therefore, when he meets with a dark (almost black) deposit of this sort in the mountain limestone, and even in the coal measures themselves, will have at hand a most useful assistance in carrying on the permanent works of the mine. Mr. Smyth then proceeded to notice the various ways in which walling came into play. In the first place, at the surface of the mine it is frequently needed. The manager is often in considerable doubt as to the surface rubbish, especially if, as in the case of a slate quarry, it turns out a much larger proportion of rubbish than of valuable slate. He may have to erect a retaining wall to prevent the rubbish going further, when it must have strength enough to resist a considerable pressure. Good examples of undertakings of this kind have lately been constructed at several of the metropolitan railway stations, where the strength of the walls is increased very greatly by a series of cells. Proceeding to the subject of underground work, Mr. Smyth said that in simple walling a convenient way was to build up the sides, and then place slabs of timber across, but, of course, the timber would require to be renewed from time to time. If, however, the pressure is very great, some other material will have to be put in partially, if not wholly, or where the line of resistance is most direct. Proceeding to the next case, that of lining the roof of levels, the first point is to decide what form the roof shall have to best meet the pressure from above. Where there is nothing peculiar in this respect, the common barrel or semicircular arch may be used. There are many very long lining levels in the North, and in Yorkshire and Derbyshire, where the walls are vertical, and the roof semicircular. The walls are mostly constructed with drystone, and the work is remarkably well done, the miners taking great care to fill in the overhead interstices with stone, so that the pressure may fall equally. If the pressure should be on one side the vertical wall will bulge in, and in that may be seen the beginning of the end. It is very important to know the character of the ground to be dealt with, for suitable as the semicircular kind of arch may be in stratified rocks, when the levels are nearly or quite horizontal, it is not at all suitable where the thrust comes in different ways. For this reason we cannot generally expect to introduce this form of arch into metalliferous mining. The barrel arch is the cheapest form of construction, and the best where it can done, but in lodes where the walls are strong it is more frequently feasible to put in flattened arches right across; and if the walls are weak, other and varied shapes must be put as buttresses to the walls, to defend the levels from side pressure, as well as the weight on the roof. It must also be remembered that it is impossible to calculate the force of the thrust exactly in the way it might be done at the surface. When the pressure comes from above, and from the sides also, an ellipse is the most suitable form, and it may be that where the floor is of clay that must be arched as well. [The lecturer then drew a variety of examples, and exhibited models of different kinds of arching.] Everything depended upon the judgment of the manager as to what sort of material is most applicable, and what form of arch is best. In certain collieries on the long wall system, where the roof is bad, but the floor strong, he had seen that not only the main roadways were well arched, but the subsidiary ones also, and this makes it necessary that the latter should not be placed too near each other, or the expense will be greater than the coal removed will bear.

Lecture XXX.—It is scarcely possible in any kind of mines, even those worked under the most favourable circumstances, to continue the excavations for any length of time without sinking shafts. Even in the hilly districts of Cumberland and Yorkshire, where access was first obtained to the mineral veins by long levels, shafts would after a time become necessary for ventilation, if for no other reason. It may be indispensably necessary in such levels to obtain an outlet at the further end for the workmen, and sometimes for the purpose of drawing up of the ore. Shafts of this kind might either be sunk vertically on the level, or more or less inclined; or, if not desirable to sink right upon the lode, but through the ground by its side, there may be subordinate shafts (commonly a winze), which from a succession of levels ultimately reach the surface. Many mines, however, have no special advantages of this kind, and have to be commenced from the beginning with the sinking of shafts, a portion of mining work which frequently involves enormous expense. The placing of the shafts, therefore, as well as their security, are matters on which it is of the greatest importance that the mining engineer should make no mistake. As they must have inferred from what had already been said, shafts could not be begun in metalliferous mines in the same perfect way as in opening new workings upon the stratified deposits. The most convenient spot in the case of a colliery will mostly be that which will best serve for drawing off the water of a given area, and which will be best placed for the mineral being brought to it underground, as well as for the delivery of mineral at the surface. If they took an isolated coal bed, at no great depth, with the dip from north to south, it would be obvious that the best place for the shaft would be the extremity of the dip of the measure; but if they were dealing with beds of great depths, that might incur vast expense, such as an individual, or even a company, naturally would shrink from, they must place the shaft on some intermediate spot, from which the seam could be worked at a less depth. Another point to consider would arise out of the removal of coal underground to the shaft, and for this purpose it was obvious that it would be best to place the main shaft in the centre of the area to be worked. In this case (and it was often provided for by a clause in leases for other purposes) a certain breadth of the seam should be left all round the outskirts of the area, so as to prevent the water from the surrounding districts getting in, and thus impeding, if not preventing, future operations with a view to getting the lower seams. This might be effected either by sinking the shaft to a lower depth (which was the most common method), and cross-cutting, so as to intersect the seam at a lower point, and haul the mineral through that opening. Or, if the ground were not very watery, the cross-cut might be driven in an inclined direction to the deeper point. But in these cases great care must be taken as to the arrangements for drainage and ventilation. A third plan was, if the beds to be opened were not much saturated with water, to sink on to the bed itself, but this would not be possible if any water came from the roof or ground; and it was not advisable, also, when there was much irregularity or many dislocations in the beds. The reason so much care and thought were requisite in the matter of shafts was the great expense of sinking them. An ordinary shaft, in commonly fair ground, and not more than a few hundred feet deep, would cost from 5000*l.* to 10,000*l.*; and if they went to greater depths they would find the figures come up to 40,000*l.* or 50,000*l.*, and cases might be quoted where the cost was much greater than that. There were two or three sinkings in the North of England in which the shafts, with the requisite machinery, had not cost less than 100,000*l.* to 150,000*l.* In the same way in metalliferous mines, where the rock cut through was of extreme hardness, such as granite and killas, the cost of a moderately deep shaft would be from 15,000*l.* to 25,000*l.* It was, therefore, a most serious consideration, as if the start should be made in the wrong place, and these great depths had to be reached, they could not expect the capital embarked to hold out against such heavy expenses, or the courage of a company to be equal to such an expenditure, in the face of so much uncertainty of success in the end. The great outlay the sinking of shafts involved, no doubt, led to the practice of bratticing—a division down the centre of the shaft, which was thus made to do duty as two shafts, both as to ventilation and drawing the coals. A great deal of good work had, no doubt, by this means been done by a single shaft, but since the terrible accident at the Hartley Pit, the result of a concatenation of omissions and misfortunes, an Act of Parliament was passed, requiring that there shall always be a second outlet. This, however, was scarcely a satisfactory arrangement if a large area had to be worked from the bratticed pit. In metalliferous mines, however, where it frequently occurred that only a small piece of ground was to be worked, bratticing answered well for a short time; but, after all, it was an satisfactory mode of working, as the ventilation would soon begin to be imperfect, and another shaft must then be sunk, a necessity which, he must say, the managers of metalliferous mines were always ready to realise and quick to supply. The reason why this system prevailed at all was that the sinkings were often only exploratory at first, and were, therefore, put down with a view to shallow depths, and might have to be abandoned altogether. Hence there was a great difference in the shafts or pits of collieries and of metalliferous mines, both as to expense, number, and position with reference to each other. There were, however, very often special circumstances at the surface, which must be considered in placing the shaft, whether for collieries or metalliferous mines, but particularly the former. Suppose, for instance, a line of railway or a canal running across the area to be worked, or in its immediate vicinity, the shaft would naturally be placed with some reference to such an advantage. Or, again, supposing the occurrence of a deep valley at the surface, it would be less expensive to sink there than on the tableland or hills by its side, and the seams under the latter might be worked thoroughly out. Examples of this kind are numerous in hilly districts, such as South Wales. It was usual now to commence with a pair of shafts together, which enabled the managers to provide from the first ample means of ventilation; and afterwards, according to circumstances, it might be found advantageous, in a large concern, to sink shafts in other portions of the ground. The lecturer referred, as an example, to the Risca Black Vein Colliery. In metalliferous mines there were other points to be taken into consideration. In deciding as to which was to be the pumping pit in the case of stratified deposits there could be no difficulty at all, as they had merely to place it at the deepest point to which they could obtain access, which could be generally ascertained by the lie of the ground; or, where this was impracticable, by bore-holes sunk for the purpose. Indeed, it was often found beneficial to keep a pumping engine at work in the ground from which the coal had been all taken out, in order to prevent the water communicating with other portions of the district which were being worked, and in some instances colliery owners contributed a certain proportion towards the expenses of a pumping engine, which would drain several properties. Let him now turn to metalliferous mines, and suppose they were intending to work a certain area. It was impossible for them to make any calculation as to the kind or position of the shafts they would require. They could not say at first whether they should be perpendicular or inclined, nor whether they would require one or more. They would have to test the ground from fathom to fathom before they could come to any fair conclusions on the subject. They might form an estimate, from the nature of the rock, how much it would cost to sink a couple of shafts a certain number of fathoms in depth, but nothing beyond this. Let him take the case of the Carn Brea Mine, one which had attained considerable dimensions. There a shaft had been sunk perpendicularly down to the Druid south lode, a depth of 40 fms., but, under ordinary circumstances, no one would ever dream of recommending that a perpendicular shaft should be put down to that depth in the first instance. They would rather proceed by a succession of steps. Supposing, then, they had sunk a shaft which proved not to be on a good portion of the lode, it would be necessary to sink a second, and perhaps a third, shaft at a short distance from the first, and in this case they would naturally ask how they were to determine where to put the permanent pumping engine. This was a point of very considerable difficulty. If they commenced at No. 1 shaft, and put up extensive machinery there, it was obvious that the great expense incurred would, to a great extent, be thrown away if they should have to make No. 2 or No. 3 shaft the principal point of operations. The expense would not be entirely thrown away, as No. 1 shaft could be rendered available for draining the mine by means of horizontal rods. In order that no great risk should be run, it would be preferable to erect temporary machinery at the outset, and then, if the principal part of the lode had been struck, it could be removed, and machinery of a permanent character erected in the most convenient position. Indeed, it was now usual to sink temporary shafts, and have temporary engines, which might be conveniently removed, and which were called "flat-rod shafts" for this reason. With regard to shape, it would be found that in colliery districts shafts are all either round or elliptical; while in metalliferous mines they were almost invariably rectangular. As to their dimensions nothing definite could be said. In Somersetshire some old shafts were found not more than 4 or 5 ft. in diameter, but at present it was seldom that they were made of less than 6 or 7 ft. diameter, whilst if they were intended to do a considerable amount of work, they were generally as much as 12 ft. Mr. Smyth drew attention to a diagram on the wall showing a section of the strata passed through in a recent sinking at Shireoaks Colliery, near Worksop, carried out by the late Duke of Newcastle, and which had attained the depth of 500 yards, to illustrate the great variation in the character of the ground, and also the difficult questions which arose when sinking in certain portions of it, not merely as regarded the hardness of the rock, but as to the quantity of water that made its way into the shaft. This was one of the finest shafts in all England for excellence of work and the interest which arose from the difficulties of the sinking. It was of considerable size, 16 feet in the clear. Some were to be met with in South Wales and in the North of England as much as 22 ft. diameter. In Belgium, where shafts were much deeper than any in England, they were generally polygonal in form, whilst a few were circular. In metalliferous mines it was usual to construct the shafts for ordinary winding purposes 6 feet by 5 feet, whilst the engine-shaft, where they required more room for the pumping rods and the placing of the ladders, &c., were generally about 9 feet by 6 feet, and sometimes 10 or 12 feet by 6 feet, especially if the shaft be intended to serve several purposes. Exceptionally large shafts were met with in the Hartz and Hungarian mines, where they were frequently 18 ft. in diameter, and in parts of Mexico some of the shafts were of enormous width. He had seen a shaft in the Westphalian coal field which was upwards of 30 feet in diameter; but it proved too great a task to be carried out with safety, and the ambitious engineer who attempted it had to give it up. The fact was, the difficulties met with in attempting to sink a shaft of those dimensions in difficult ground, where there was a considerable pressure from the sides, and where there was a large quantity of water to contend with, were almost insuperable, or were only to be overcome at a cost quite incompatible with a commercial speculation. In mining they were not backed by the vast capital of a railway company, and the mining engineer must so plan his outlay as to bring in a return as early as possible for what is expended.

He would now pass on to a comparison between perpendicular and inclined shafts. In dealing with stratified deposits, it was seldom desirable to put down inclined shafts. It was true that in working some seams of coal—such as one occurring in the neighbourhood of Swansea, where the bed was elevated at a very considerable angle—it was an open question whether they might not advantageously sink in the coal itself, and work a colliery on a considerable scale without the necessity of perpendicular shafts; still these inclines were open to an objection, on account of the very great wear and tear of the wagons and drawing-gear, as compared with the drawing of the mineral perpendicularly; besides which there was the difficulty of keeping the inclined shafts open. In collieries, therefore, the shafts were ordinarily perpendicular; but with metalliferous mines the case was very different, and it was curious to see how inclined shafts had become almost the rule, to the exclusion of the others. In Cornwall and Saxony the verdict was very much in favour of inclined shafts, and very naturally so, because in those districts the deposits were inclined at a considerable angle. In many cases the shafts were sunk entirely in the lode, and thus the sinking was paid for by the ore extracted. Supposing they were to sink perpendicularly to a metalliferous vein, they must either sink on the hanging-wall side until they intersect the vein, or on the footwall side, and then drive cross-cuts through dead ground to intersect the lode, in either of which cases considerable expenditure and loss of time had to be incurred before they saw anything at all of the lode. It was surprising how some miners, especially in Ireland, preferred to sink on the foot-wall side of the lode, as it was obvious that if the lode dipped away at a considerabfe angle, by putting a shaft on the foot-wall side the farther they went down the farther they would be from the lode, and the greater distance would they have to cross-cut to get at it, whereas by sinking on the hanging-wall side they would intersect the lode. Another class of shafts frequently employed in metalliferous mines were the inclined shafts sunk between the walls of the lode, and which were generally oblique, not merely in the sense of deviating from the perpendicular, but oblique as regarded the longitudinal section of the lode. The most remarkable cases, perhaps, of that kind of shaft were to be seen in the under-sea mines at the Land's End, where the best possible reasons exist for adopting them. The Botallack and Newcastle mines were examples of this, inclined shafts having been driven for a considerable distance, 85 fms. or 95 fms., perhaps, in the former, through hard, close quartz, which did not contain tin or anything else. In certain countries, such as the Hartz, and in Hungary, perpendicular shafts were prefered; in fact, mine officers in general were divided into two hostile camps, as it were, on this subject; but, as a rule, there was some peculiarity in the occurrence of the beds, which had led to the adoption of certain forms of shafts in the different districts; and when the lodes were large and soft it was better to sink a perpendicular shaft, and work by means of cross-cuts. When, however, they had to sink on the mineral itself the softer it was the more dangerous it was, and the more necessary that the shaft should not be of these large dimensions.

Lecture XXXI.—They would now proceed to consider some of the points connected with the sinking of shafts with a proper amount of security for the men occupied in what must always be, more or less, a slow and dangerous work. It was very seldom in metalliferous mines that they attempted to sink to any considerable depth without taking especial care to protect the men from any materials which might fall down the shaft; hence it was usual to construct over them what was called a "pent-house." This consisted of a number of strong pieces of timber, placed crosswise in the shaft, filled in with planking. A small opening was left in this covering, to admit of the passage of the kibble or bucket used in the sinking operations, and also for the men to pass through. It would commonly be the case, however, that to carry the system of pent-houses out satisfactorily they would have to put a small windlass, so as to raise the material excavated as far as the pent-house, and afterwards raise it to the surface by the machinery at the top of the shaft. He mentioned these precautions as being very much in opposition to the plan ordinarily adopted in sinking the vertical shafts in stratified deposits, where they seldom took any precaution of that kind, and where they sometimes saw a yawning shaft, perhaps 200, 300, or 400 yards in depth, without the slightest precaution being taken to keep away strangers or protect the men below from the fall of a plank, or tools, or rubbish, or other like dangers. They must next consider the best mode of protecting the sides by means of timber. Ultimately they might desire to put in brick or stone work; but, in the meantime, for temporary purposes, timber would generally be employed, and in most of the metalliferous mines timber remained as the means of protection. In the case of a shaft at the Tresavean Mine, which went down to a depth of 310 fathoms, and which had been sunk for some distance in solid granite, which, being extremely hard and tenacious, would endure for years without any artificial protection: but even granite, where it was jointy, where strings passed through it, where it was decomposed, or where it was intersected by cross-cuts, might be far from secure. Then, again, at the Samson Mine, at Andreasberg, there was a shaft which inclined first in one direction, then became perpendicular, then it inclined in an opposite direction, and again followed the perpendicular. Here, too, strata had been passed through of which as much as 100 fathoms required no timbering, whilst other parts of the same shaft taxed all the resources of the timberman to make them secure. Now, as to the means to be adopted for securing shafts, he would take one or two simple cases first, and it must be noted that it was very desirable at the outset, if the mine were

to be timbered from the surface, that they should lay out the plan of the shaft very definitely, and get their angles correctly. If, for instance, they were about to sink a rectangular shaft, it would be necessary to employ plumb-bobs at the angles, so as to preserve the planes of the shaft perfectly consistent throughout. The manager should not allow the sinking to go on for many feet together without testing whether the angles were being kept perfectly true, and although, at first sight, it might appear a very simple matter to keep them so, there were very few shafts indeed where an active and constant supervision was not exercised during the progress of sinking which did not pass off from the perpendicular line in either one direction or the other, and perhaps in both, and sometimes to an extent almost inconceivable. The consequence was that, when after a time they had to put in some powerful pumping machinery, they found their main rod come against the wall of the shaft, and then came the question how to keep it away from the side, which very often involved the cutting away of fathoms and fathoms of ground, delaying the working operations, and sometimes making it a question whether it was practicable to continue to work the mine, or otherwise. He had seen one or two very remarkable cases of this sort within the past few months. It was less expensive to sink a shaft perfectly true than otherwise; but the great expense required to put a shaft right after it had been completed could scarcely be conceived. Supposing, then, the shaft to be sunk straight, in the proper place, and in the proper way, the scale of the shaft must be considered as determining the scale of the timbering required. If it were merely exploratory, to test the position of a vein, or in stream works for gold or tin, such securities as those of military mining would be enough. It was usual for these purposes to lay down a frame of four pieces of 6-in. timber, with the ends projecting a foot or so, and fastened together by a few pins, the timbers being half-checked into one another, so as to lie flat. Sometimes it would be desirable to place planks across the timbers. A framework of that kind being formed, and laid at the surface, they might then commence to dig downwards, and after getting down a few feet it would be necessary to put in another framing of timber of the same dimensions as the shaft, without the projecting ends, and so on at intervals all the way down the shaft. Another very convenient kind of framework were those termed "Dutch cases," when they wanted to sink very rapidly through soft ground. Perhaps the mines where this method came in most usefully were such as the hematite mines in the North of England, where ground was very apt to collapse, and come together very rapidly. In some parts of Scotland, and in some of the alluvial districts in the West of England where there is gold streaming, a system of plank framing comes frequently into play; but the shafts are of no very great depth. But where timbering was to be put in to remain, it should be framed on a proper scale. If a shaft be intended for more than temporary purposes it will probably be convenient, in the first instance, to put in timber until a good foundation is reached, when it may be replaced by more enduring work. The lecturer exhibited a model of framework of the description used in such cases. It was a system of rectangular frames to fit the shaft, leaving behind them a series of boards, placed close together, or at some distance apart, with ordinary lining boards. It was very desirable that they should select the foundation for the bearers used for the support of the permanent timbering with very great care. In strong ground it would be sufficient to cut a hole in the side of the shaft, so as to form a ledge on which to rest the bearers; but if the ground was rather loose it was needful to take special precautions, and to place some strong head planks and spilling-pieces behind it, and the same precaution should be taken to secure the footing or bearer before they placed anything upon it. Mr. Smyth then described on the board the arrangements for building the setts of timber in the shaft as they advanced, the details varying according to the nature of the ground. With regard to the fitting of the frames at the joints, the common method was to half cut away the timber where it joined, and fit one in another; but the Cornish miners had an excellent mode of fitting the frames together, which the lecturer illustrated by means of a number of pieces of wood prepared for the purpose, and which, when put together, formed a framework possessing in itself great coherence and stability in every part. These frameworks would either be placed one upon another, or set at intervals with "studdles," or corner-pieces of timber, placed between them. If the ground were watery, it might be necessary to put in close timber, the boards being fitted closely together, in which case they would keep out a great deal of water. Several other modes of timbering were adopted, which Mr. Smyth illustrated either by drawings on the board or by models, one of which was peculiar to the mines of Hungary and the Hartz. The plan adopted in those districts, where timber was very abundant, was to take two pieces of timber, and place them a couple of fathoms apart, as wall-posts; and behind them, according to the strength of the ground, they would place long pieces of timber, extending from side to side; and, in addition, diagonal struts would be put in from side to side, to prevent the wall-posts from coming together. As to the timbering of inclined shafts, it was seldom the case that anything different to the system he had already spoken of was adopted; but when the inclination was considerable, the arrangements were very similar to those he had described as being employed in the securing of levels. An enormous variety of circumstances came into play from irregularities in the ground and other incidents, which would tax the ingenuity and invention of the mine manager to the utmost, as to the best forms, slopes, and principles of timbering to be applied.

LECTURE XXXII.—Before he proceeded to describe further means of securing the actual shafts, he might as well indicate some modifications of the arrangements necessary at the bottom of shafts for the constant and large traffic which in large workings come to a focus, as it were, at that point. There were generally lateral openings in several directions at the bottom of shafts, and it was necessary that the roadways in its immediate vicinity should be of sufficient width to allow the returning wagons to pass by those which were approaching, and also for accumulations of the mineral to be drawn out of the pit, until the engine could remove it. Great difficulties often arose in metalliferous mines for want of good arrangements of this kind. Suppose, for instance, they were dealing with a shaft which had twelve or fourteen different levels into it, and in each level, as there frequently were, four or five different working places, what was to be done with the ore or material got out, for it would accumulate, particularly if the ground were soft, while the men were at work faster than one or even a pair of engines could wind it up? It was, therefore, necessary to have store places in which the excavated ore could be put out of the way until it could be drawn up the shaft. It was a slovenly practice, but it often occurred, to allow the men to place the material along the sides of the level, sometimes filling up fathoms and fathoms in length, until the level became so blocked up that it was impassable except by creeping or crawling, and the ventilation was very much deranged in consequence. He did not know that there was any more important point to look to in metalliferous mines than to provide proper places for the storing of the material excavated, and so prevent the men from suffocating themselves by slow degrees, as was too often the case. Perhaps in no mine was this matter better attended to than in the Devon Great Consols Mine, where the whole of the levels were kept perfectly clear from any obstruction, and where at each level proper arrangements were made for the collection and storage of the material temporarily. This was done by means of a "trip-plat," or magazine, at the head of each level. The trip-plat was formed by cutting the level for some distance deeper than the remaining part, and over the deeper portion rails were laid, supported by props, and into these hollow spaces the material taken out of the level was tipped. The opening of plats in certain kind of ground was a very difficult operation, and it was always necessary to put in timbering to preserve the sides of the shaft intact. In very wide levels they might open so wide a space for this purpose as really to constitute a source of very considerable difficulty as regarded the safety of the men. In the Hartz, where they did things on a large scale, they had extensive plats, and so were able to divide the attle from the ore in the temporary stowage. Mr. Smyth then exhibited some models of English and foreign arrangements of this kind, and explained various contrivances to keep the ropes from friction when drawing ore or attle from the plats. He then passed on to consider the necessity of securing shafts by more permanent methods than timbering, adverting, first, to the arrangements carried out in securing shafts for some little distance from the surface. It was frequently the case that the timbering in places where it was alternately wet and dry, as for some yards from the surface, was apt to get rotten, and required frequent renewal; and another disadvantage of securing shafts near the surface by timber only was that, after a mine had been abandoned for some little time, and even if a shaft had been left idle for a time, the ground thus supported gave way, and the mouth of the shaft became extremely dangerous. There was no doubt that, as a rule, timbering held its own tolerably well when pressure alone had to be withstood, but there was always more or less loose ground at the surface; and, whether the mine were situated in a country like this, where we had a constant rain fall throughout the year, or whether it were in a tropical country, which was subject to large floods at particular seasons, channels of water constantly formed themselves at the surface, and the water ran down the sides of the shaft. The consequence was a subsidence of the material forming the sides of the shaft occurred, which displaced some of the timbers; and, others following, the shaft for a considerable distance in depth went to ruin, and became a vast crater, equally dangerous to man and beast. In order to avoid this, and the constant expense of repairing the timbering, it was very desirable that the upper part of the shaft should be secured either by spilling or walling. The latter was generally adopted in metalliferous mines, and where stone of suitable description was abundant when, with a good foundation, it would last for centuries. The only objection which could be urged against the employment of walling, was that ladders could not be very conveniently fixed to it, and that if they wanted to put in a soliar, for instance, they were obliged to take out some of the stones; but this was a matter of such extremely minor importance, compared to the proper securing of shafts, that it was scarcely deserving of mention. Supposing, then, it was decided to put in walling to a certain depth, it was usual first to line the upper portion with timbering of a temporary kind, until they got down to a secure foundation for the masonry—(say) clay-slate rock. Then, having previously cut the shaft a little wider than necessary, they commenced to form it of the nett dimensions required, and build up the wall of stone or bricks, taking away the temporary timber piecemeal as they advanced, until they had completely walled in that portion of the shaft. But it frequently happened that they could not get a good foundation for the walling, or that portion of the shaft might be in the lode itself, and that, therefore, the very working away of the lode might cause portions of the side to come away, and render it impossible to get a foundation. In these cases it was often the case that the walling was supported on cross timbers; but, of course, that would only last as long as the timber endured, hence that would not be considered satisfactory for shafts intended to be kept open for any length of time. The next plan was the obvious one of substituting an arch for the pieces of timber, and that was a plan which ought to be adopted very much more frequently than at present in metalliferous mines, and was the system upon which a great deal of excellent work was carried out in Saxony, and also on a smaller scale in other districts. There were one or two other modes of walling to be looked to. When the sides of the shaft were more or less yielding, it is usual to arch all the four sides, like a parallelogram. That brought them very near, in fact, to the subject of the elliptical or circular shafts ordinarily employed in collieries. The mode of walling adopted in the latter forms of shafts would be more or less similar to that he had already described; but, in proportion to the difficulties met with—such as quicksands, or ground which allowed water to come in, or the meeting with water itself—devices of a more exact kind had to be resorted to. Suppose a circular shaft were intended to be 12 feet diameter in the clear, the engineers would begin sinking with dimensions considerably larger. First of all, a couple of strong baulks of timber would be laid across the ground at the surface, capable of sustaining very heavy weights, as, for instance, the timbering which would be put in subsequently, the masonry, or the pump-rods for the draining of the shaft. They would then dig a short way down, and when a sufficient depth had been excavated, put in a framework of timber—the mode of constructing which Mr. Smyth described in detail—then, digging still deeper, other frames of timber would be put in at certain intervals, punch props being placed between them to keep them asunder until they reached a foundation. Supposing they did not find the natural rock strong enough, a temporary foundation of timber would be put in, and the process repeated, probably, many times if the shaft were deep; and when at length a solid foundation was secured, those temporary ones would be taken out bit by bit, and replaced by permanent work. There were many modifications of this simple style of work, as, for instance, occasional curves projecting from the brickwork, as a precaution against a partial disturbance of the shaft by the dropping of some particular part of it. In Derbyshire it was the custom to base the brickwork on square frames, which projected at the corners a few inches into the ground. One of the most remarkable examples of a finely-constructed shaft is that at the deep sinking at Dukinfield, in Cheshire, where the work had been admirably carried out. The brickwork was 9 inches thick, of bricks formed especially to fit the sweep of the curve, and set in the well-known Hardwick hydraulic lime, which is found in that neighbourhood. At intervals of about 8 yards curves of stone are put in, 18 or 20 inches wide and 12 inches in thickness, projecting into the measures. It might be necessary, even when sinking in not very difficult ground, and when they could not wait until they reached a good foundation to connect the timber framework which sustained the brickwork with the baulks at the top of the opening, but this was, of course, only a temporary expedient.

LECTURE XXXIII.—Mr. SMYTH said the methods of protecting the sides of shafts, which he had so far placed before them, were intended more particularly for preventing the sides from breaking in, and also for keeping out to some extent a certain quantity of water, especially near the surface, where the close timbering to which he had referred was very often applicable. But it happened under a great variety of circumstances that they must have recourse to some method which would keep out water more effectively than any of the plans he had referred to, and during the last half-century a great advance had been made in the possibility of carrying out the systems of lining shafts so thoroughly as to exclude the water, which would otherwise be constantly filtrating into the shaft, and entail on the proprietors the constant and heavy expenses of pumping it out by means of machinery. It would be well first to point out a few of the cases in which the system of tubbing, or coffering, became applicable, because it was a method which, although involving a great expense at first, was, nevertheless, where it could be applied so admirable a means of avoiding ulterior expense that it was most important that every mine manager should be perfectly competent not only to judge of the cases in which it might advantageously be employed, but also to select that method, and that kind of tubbing, and that preparation of its different constituent parts which would enable him best to combat the circumstances of his particular mine. He would take the case of a shaft having to be sunk in ground of a porous nature, more or less aproximating to quicksands, such as where they had the former bed of a river to deal with. Now, if the depth to which they had to sink be very shallow, it was a matter of very little difficulty with either wood, stone, or brickwork, to keep out the water, but when they got down to a depth of, say, 50 or 60 feet, and had to contend with the great pressure due to a column of water of that height, they would necessarily have at the bottom of the shaft so great a pressure as to cause very great difficulty in keeping out any water that found its way through the chinks of ordinary timber, however close it might be put in. The way to keep out the water was to put in a water-tight joint at the base of the watery ground, in such a way that the water should not get past the joint. This was a matter of considerable difficulty, but supposing they had effected it, they might then continue sinking, and probably get into a rock which was water-tight, and so complete their sinking without the necessity of pumping; but if, as was very frequently the case, they got down to measures—coal measures, he would suppose—dipping at a certain angle, and which they reached at a point where they intersected the water-bearing bed, they then came upon a source, probably, of very great difficulty. Suppose that water-bearing bed were intersected by the shaft, they must, of course, of necessity commence by pumping that out, in order to allow the men to continue their work; and then arose the question of the depth and character of the bed, and whether they were able to keep the water out by some system of tubbing. Still this might, under favourable circumstances, be effected by sinking a shaft through the water-bearing bed to begin with, down into a water-tight portion of the ground, where putting in such a foundation as he had before referred to, and making it perfectly firm, they might build up all round the shaft tubbing—that was just as a tub was made to contain water within it, so tubbing was constructed to contain water outside, so as to prevent it from coming between its sides. Then, having put in tubbing through the whole of the water-bearing bed, they would put another water-tight joint at the top of the tubbing, and so the water would be kept out of the shaft, and they might continue their sinking in dry ground, or with very little infiltration of water. If, unfortunately, they meet with an alternation of the water-bearing ground, they would have to repeat the same process of tubbing. Then, if fortune favoured them, and they got a perfectly secure shaft, they might open out a large colliery without the necessity of employing pumping machinery. The water-bearing beds might occur frequently or in one continuous length of ground, and they might sometimes sink comparatively very dry for some distance, and then come to an enormous feeder of water. The mode of dealing with cases of this kind would not differ materially from those he had already spoken of, but sometimes it would be necessary to join one length of tubbing to another, and hence a great part of the shaft might require tubbing. Great difficulty had been experienced in sinking through the Permian rocks, or magnesian limestone, in the eastern portion of our northern coal fields. The rocks of that formation contained a certain amount of water, though not very considerable, some being much more watery than others; but when they approached the bottom of the magnesian limestone they came upon what were called the Lower Red Sands, which were sometimes of considerable thickness, but were, generally speaking, so saturated with water that it came in a perfect flood, and gave rise to very great difficulties. If the magnesian limestone were very loose in its texture, they might meet with a great quantity of water at intervals all the way down, and, therefore, in sinking through that kind of strata, it had been necessary, instead of waiting until they get a perfect foundation for the tubbing, to put in a temporary foundation at a shallow depth, to carry their tubbing from that foundation upwards far as requisite, then to sink to a greater depth, until they came to a place suitable for a second foundation, from which they could put in tubbing as far as the first foundation, and so repeat the operation until they had completed their sinking, when a firm foundation would be got, and they could commence to build up the tubbing afresh. In order to give them an idea of how serviceable tubbing was, he would give them some examples in which great difficulties had been met with in the sinking of colliery shafts. Many of those cases had occurred in the northern coal field, but they were by no means confined to that neighbourhood, as some remarkable cases had occurred in the Belgian coal field, in the North of France, and in Westphalia, where a similar difficulty to that he had referred to as incident to our northern coal field was met with, in certain beds of the chalk series, and especially in some loose watery beds at the lower part of the chalk or cretaceous system. There it had been necessary in several instances, as also in the North of England, to surround the pit, whilst sinking, with a whole group of steam-engines, having a total power of from 1000 to 2000 horses, for the purpose of pumping the water out, whilst the men were enabled simply to get down until they could establish a water-tight foundation. Now, supposing they had to employ a force of 1000-horse power, it would be quite impossible to carry on a mine economically, and yet this was only a moderate amount compared with what had been requisite in some cases. Of the examples on record of sinkings which had been carried on under great difficulties, he might mention that of the famous sinking of Murton, in the North of England, were it was attempted to sink two shafts, of 14 feet diameter each. At that operation the engine-power consisted of no less than three engines of 120-horse power, intended ultimately for winding; one engine of 120-horse power, which was intended to be the pumping-engine, besides a number of smaller engines, and each of these had attached to them sets of pumps, of from 16 in. to 19 in. in diameter. The quantity of water raised by this means was as much as 3285 gallons per minute, and yet this has hardly sufficient to combat the feeder which was met with. That single case would show them what great difficulties were encountered in some of those pervious strata. Now, if a feeder were met with at considerable depth, of course the difficulties were greatly increased, and he might mention that, whilst at Murton the depth of that watery stratum was 76 fms., which was the depth at which they reached the bottom of the magnesian limestone, at Monkwearmouth it was only 52 fathoms, and at South Hetton, another famous colliery, sinking also through the magnesian limestone, it was met with at 64 fathoms. He need not, however, further occupy their time by urging the importance of employing tubbing, as the facts spoke for themselves; but he would just draw their attention to a diagram on the wall, representing a shaft sunk not very long ago by the late Duke of Newcastle, where it had been necessary to put in tubbing for a distance of 170 yards in one continuous length. In many cases a comparatively short length of tubbing might suffice, but in others it was necessary, after sinking to a considerable depth, to put in a much greater length than they had, probably, intended at the outset. One point which had to be considered before they resorted to tubbing was this—that a great deal depended on the pressure with which water found its way through the fissures of the rock, and, therefore, if a watery bed were met with at a great depth—(say) 200 yards—it was important to note where the water came from. It might be that the water came from hilly ground, giving rise to a large column of water, of such a pressure that very strong tubbing would be required to keep it back. If the country beyond were flat, however, the column of water would not be so strong, and tubbing of a weaker description would suffice. Sometimes it was possible, by examining the surface, to cut off some of the water at the outcrop of the seam. The materials which had been employed in tubbing were very numerous. Brick or stone walling, with hydraulic lime or cement; wood, which was commonly used now-a-days in Belgium and France, and formerly in our Northern coal field, as well as wrought and cast iron, had been employed for the purpose. It was very important to get all the facts they could relative to former sinkings in difficult ground, hence he might state that much might be gleaned in reference to the sinking through the magnesian limestone in the northern coal field from the Transactions of the North of England Institute of Mining Engineers. Now, of the various methods of tubbing, one of the simplest was that of sinking shafts of brick or stone work bodily. This had been very satisfactorily carried out in many cases, where the brick work was based on a curve which had strongly affixed to its lower part a lining or edge-piece of cast-iron. Upon this might be commenced the brick or stone work, which was sunk in the ground by means of beams laid across it, weighted down with other materials; and as the masonry sunk into the ground, the soft material which rose up in the middle was excavated, and in this way a great depth of masonry might be sunk bodily down. It was very necessary to look to the verticality of the sinking by this method, as this was apt to be interfered with by inequalities in the ground, such as the meeting with stones, &c., which it would be necessary to hitch out. This plan had been more particularly adopted in Westphalia, where in some instances great expense had been incurred in carrying it out, notwithstanding which many of the sinkings had failed when the full pressure of the water came to bear upon them, that was when the pumping-engine had been stopped working. The form chiefly adopted in Westphalia was the four-sided shaft, the sides being curved so as to be almost rectangular. Sometime stone was employed and at others bricks, and it had been calculated that if the bricks were 10 in. in length, where the pressure or depth was 15 fms., the sides must not be less than two bricks; if 25 fms., it should be two and a-half bricks; if 45 fms., three bricks; if 55 fms., three and a-half bricks; and if 60 fms., four bricks. The results, however, obtained by walling he could not say were so satisfactory as other kinds of tubbing. Mr. Smyth next alluded to the employment of wood in the operation of tubbing, but although this had been found preferable to walling, it had been almost entirely superseded by the use of either cast or wrought iron. Wrought-iron had not been employed very extensively, nor, on the whole, had it been found to answer very satisfactorily, there being but few examples of its use at great depths. In some instances it had yielded to the pressure brought to bear upon it, and had been forced into the shaft. The fact was, cast-iron could be obtained in this country with such facility, in any form and of any weight, that almost every other material had given way to its use. Before speaking of cast-iron, however, he would give them a few details in reference to the employment of solid wood, which was used to a small extent in this country, but very much more extensively in Belgium and the North of France, where it was preferred on account of its economy. One remarkable instance of its use occurred in the prolongation of the great coal field of Sarbruck, at Carling, in the department of the Moselle. At the mine in question tubbing composed of solid wood had been put in to a depth of 160 metres (the same depth as the Shireoaks Colliery) in one continuous length, and the results had been very successful. A great number of the shafts in the neighbourhood of Charleroi, Liége, and, in fact, over a great portion of Belgium, were tubbed with the same material. In this operation a wedging curve, locally termed a "trousse," was employed, which was doubled in places where considerable pressure was anticipated. In order to make a thoroughly water-tight joint between the curve and the rock it was necessary to wedge them very closely, by putting in a series of wedges at the back of the curve, and between its several joints. Passing on to the subject of iron tubbing, it had been very largely employed in the water-bearing beds of the Northern coal field. About the commencement of the present century it was proposed to sink large cylinders of iron into the ground, for the purpose of forming shafts, and this was a very feasible method of sinking small shafts. But in attempting to sink large shafts by this means it was found extremely difficult. Then it had been suggested that the tubbing might be cast in segments, and taken down the shaft separately, and then screw-bolt them together; but this plan, although carried into effect, was not found to be very satisfactory. For instance, there was great difficulty in getting the segments to fit true, and when the pressure came to act upon this form of tubbing it was found that the screw-bolts gave way. The first modification of iron tubbing he had named—that of employing cylinders cast in pieces and lowered into the ground—was introduced at the Walker Pit about the year 1795; the second plan, that of casting the iron tubbing in segments, and bolting them together in the shaft, was introduced by Mr. Buddle, in 1796; whilst the modern system of tubbing, with the flanges outside, and building up the tubbing from a foundation at a certain depth in the shaft, was introduced by Mr. Buddle in 1804. The latter system was very analogous in the mode of putting it in the shaft to that adopted in the case of wood work, the great care having to be exercised in the laying of the wedging curve for the foundation. The little model before them was so well carried out in detail that it would, perhaps, show better than any description he could give what the process was. The wedging curve was, as he had said, laid in precisely the same way as in the case of wood, and it might be either single, double, or threefold, according to the requirements of the ground. Between the joints of the curve were laid thin sheets of deal, and at the back of these, and between all the segments wedges were driven in as far as possible. The whole of the space at the back of the curve should be filled with wedges, so long as they could open a space between the fibres of the wood with a chisel. Having securely laid the curve or curves, they then proceeded to build upon them tubbing proper, which should previously have been cast in segments of convenient length. Between all the joints of the tubbing a sheet of deal was placed, and at the back a brick wall was built, the space between which and the tubbing was filled as closely as possible with wedges. After tubbing the entire extent of watery ground, they would then proceed to wedge the whole of the segments together, as well as to fill up the holes which had been left at intervals for the discharge of the water into the sump whilst the tubbing was going on. This operation being completed, they would wait with considerable anxiety for a short time, in doubt whether their work would prove successful or otherwise, as then came the chief test of the whole operation. The tubbing was made of variable thickness, it being sometimes as much as 1¼ in. or 1¾ in. thick. Its strength, however, depended not only on the thickness of the material, but also upon the height of the segments, which, in cases where the pressure was not great, might be made 3 feet or 3½ feet high; but where the pressure was considerable, they would have to be from 2 feet to 18 in. or 14 in. in height only. Of course, when the segments were very shallow in depth a much greater amount of labour was involved; and some idea of the amount of workmanship might be imagined, when he mentioned that in the putting down of a wedging curve alone in a pit of moderate diameter (say, 12 feet), where three rows of curves were required, no less than 25,000 wedges had to be driven in during the operation. Although the expense of tubbing was certainly very great, the advantages to be derived from it more than counterbalanced the cost.

THE BORAX LAKE OF CALIFORNIA.

We extract the following from the "San Francisco Mercantile Gazette and Prices Current" of Jan. 9, 1867:—

BORAX.—The source of supply of this mineral is a large and shallow basin, called Borax Lake, near Clear Lake, in Napa Co., California. The owners of this property, desiring an authentic statement of its value and resources, have availed themselves of the services of Mr. J. Arthur Phillips, of London, who consented, in the midst of pressing engagements during his recent short sojourn in California, to visit Borax Lake, and report his opinion of it. The following is a synopsis of the descriptive portions of his report:—The sheet of water from which the supply of borax is obtained is separated from Clear Lake by a range of hills belonging to the cretaceous period, and has, under ordinary circumstances a length of about a mile, with an average width of half a mile; but its extent varies somewhat at different periods of the year, since its waters cover a larger area in spring than during the autumnal months. No stream of any kind flows into this basin, which derives its supply of water from the drainage of the surrounding hills, as well as, in all probability, from subterranean springs discharging themselves into the bottom of the lake. In ordinary seasons the depth thus varies from 5 ft. in the month of April to 2 ft. at the end of October.

The borax occurs in the form of crystals, of various dimensions, embedded in the mud of the bottom, which is found to be most productive to a depth of about 3½ ft., although a bore-hole, which was sunk near the centre to a depth of 60ft., is said to have afforded a proportion of that salt throughout its whole extent. The crystals thus occurring are most abundant near the centre of the lake, and extend over an area equivalent to about one-third of its surface; but they are also met with, in smaller quantities, in the muddy deposit of the other portions of the basin—some of them being, in the richest part before alluded to, over a pound in weight. The largest crystals are generally enclosed in a stiff blue clay, at a depth of between 3 and 4 ft., and a short distance above them is a nearly pure stratum of smaller ones, some 2½ or 3 in. in thickness, in addition to which crystals of various sizes are disseminated throughout the muddy deposit of which the bottom consists. Besides the borax thus existing in a crystallised form, the mud is itself highly charged with that salt, and, according to analysis of Prof. Oxland, when dried affords in the portions of the lake now worked (including the enclosed crystals) 17·73 per cent. Another analysis of an average sample, by Mr. Moore, of San Francisco, yielded 18·86 per cent. of crystallised borax. In addition to this, the deposit at the bottom of the other portions of the basin, although less productive, still contains a large amount of borax. It has been further ascertained, by making pits on the lake shore, that clay, containing a certain proportion of borax, exists in the low ground at a considerable distance from the water's edge.

The borax at present manufactured is exclusively prepared from the native crystals of crude salt, whilst the mud in which they are found is returned to the lake after the mechanical separation of the crystals by washing. The extraction of the mud is effected by the aid of sheet-iron coffer dams and a small dredging-machine. Until recently, the only apparatus employed consisted of a raft, covered by a shingled roof, which has an aperture in its centre about 15 ft. square, and above which are hung, by suitable tackle, four iron coffer dams, 6 feet by 6 feet and 9 feet in depth. This raft or barge is moored in parallel lines across the surface of the lake, and at each station the four dams are sunk simultaneously by their own weight in the mud forming the bottom. When they have thus become well embedded the water is baled out and the mud removed in buckets to large rectangular washing vats, into which a continuous stream of water is introduced from the lake by means of Chinese pumps—the contents of the cisterns being at the same time constantly agitated by means of rakes. In this way the turbid water continually flows off, and a certain amount of borax is finally collected in the bottom of each tank, which is subsequently re-crystallised; but from the density acquired by the washing water, of which no less than 70,000 gallons are daily employed, it is evident that less than one-half of the borax existing in the form of crystals is thus obtained, whilst that which is present in the mud itself is again returned to the lake. The dredging-machine recently introduced is a decided improvement on the coffer dams, and may, by the aid of some trifling modifications, be made a very efficient machine; but the mud brought up by it is subjected to the washing process before described, and a small proportion only of the borax is obtained for re-crystallisation.

The crystals of crude borax thus daily obtained now amount to about 3000 lbs., and after being carefully washed they are dissolved in boiling water, and re-crystallised in large lead-lined vessels, from which the purified borax is removed into boxes, containing 112 lbs. each, for the purpose of being forwarded to San Francisco. The product of refined borax now daily obtained appears to vary from 2500 to 2800 lbs., which is prepared and packed for market.

It is evident from the foregoing description that the present system of working is by no means calculated to develope the best results which this property is capable of affording, and that in order to do so it will be necessary to adopt some method for the lixiviation of the mud. The total extent of this muddy deposit considerably exceeds 300 acres, and if we assume that of this area only 100 acres, or that portion now worked for borax crystals, is alone sufficiently rich to pay the expenses of treatment, we shall arrive at the following figures:—One hundred acres are equivalent to 484,000 square yards, and if the mud be worked to the depth of only 3½ ft., this represents 565,000 cubic yards; or, allowing a cubic yard to weigh a ton of 2240 lbs., which is a very low estimate, the total weight of 100 acres of mud in its wet state will be 565,000 tons. If we now assume that the mud extracted from the lake contains 60 per cent. of water, this will correspond to 226,000 tons of dry mud, containing, according to the mean of the analyses of Prof. Oxland and Mr. Moore, 18·29 per cent. of borax; but if in practice only 12 per cent. of borax be obtained, this will represent 27,120 tons of crystallised salt. A careful consideration of the phenomena attending the production of borax, leads to the belief that its formation is continually going on, by the decomposition of carbonate of soda, by boracic acid emitted from sources beneath its bed. Should this prove to be the case it is probable that any moderate extraction of borax may be replaced by the formation constantly taking place.

SULPHUR BANK.—The sulphur bank, which presents the usual characteristics of such formations, is situated on the shore of Clear Lake, and covers an area of about 40,000 square yards. In addition to sulphur, small quantities of cinnabar are found in this locality. The deposit has not as yet been extensively developed, but has already afforded 400 tons of refined sulphur. From the limited extent of the explorations which have been made, it would be difficult to estimate the probable total yield of sulphur, but it is not unreasonable to anticipate that the bank contains at least 15,000 to 20,000 tons of that substance,

IMPROVED TURBINE.—An improved inward flow turbine, invented by Mr. A. WARREN, of Boston, who has had long experience as a manufacturer of this class of machines, has recently been introduced into America. The wheel has an improved disc-stopwater which effectually prevents leakage at the top of the wheel, and at the bottom is an "auxiliary attachment" in the shape of a series of buckets arranged obliquely under the periphery of the wheel. It is impossible to prevent the gritty substances in the water from cutting away the stop waters at this point of the wheel, thereby creating a leakage and loss of power, which utilised and effectually restored by this improvement.

PUDDLING MACHINERY AT THE NORTHFIELD IRONWORKS.

Puddling iron is one of the most arduous and disagreeable labours falling to the lot of man, and it is not strange that the class of mechanics who perform it should occasionally become restive under the many annoyances of their daily toil, nor that theirs, of all the many departments of labour connected with the manufacture of the great staple of England, should be the most difficult to manage. Mr. JOHN GRIFFITHS, of Litchurch, Derby, having made a number of experiments during a long practical experience in the management of puddling forges, and having a desire to relieve the workman, so far as possible, from an exhausting toil, and to promote a more contented feeling among them, by lessening the opportunity for real or fancied grievances, at last perfected the machine shown in the above illustration, which has been erected at the Northfield Ironworks, Rotherham. This machine does not grumble at iron, however grey, and will work in the hottest weather. It is not fitful nor moody in its temperament, and, as a consequence, its product is the same from day to day, being always worked alike; and, as it is also untiring, it is enabled to work the iron longer and better than the strongest man could do. The apparatus is not complicated nor costly, can be placed on any ordinary furnace, and will not only work double the quantity of metal usually operated upon, and finish it better, but will do it with a less percentage of waste.

FIG. 1.

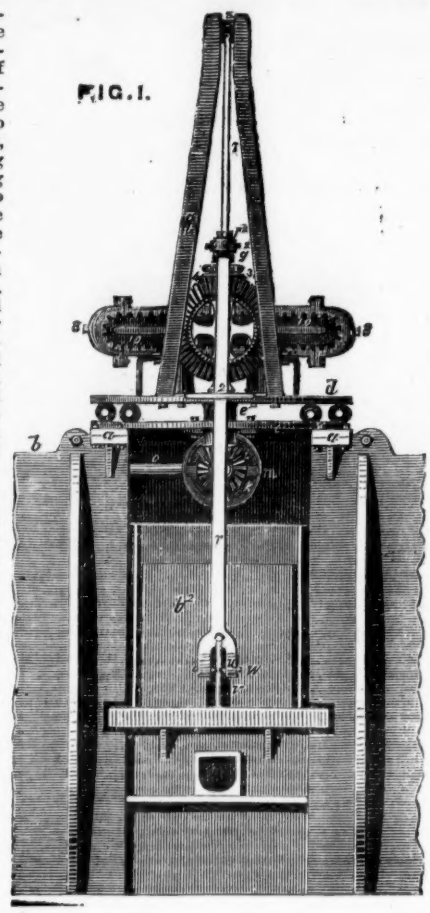
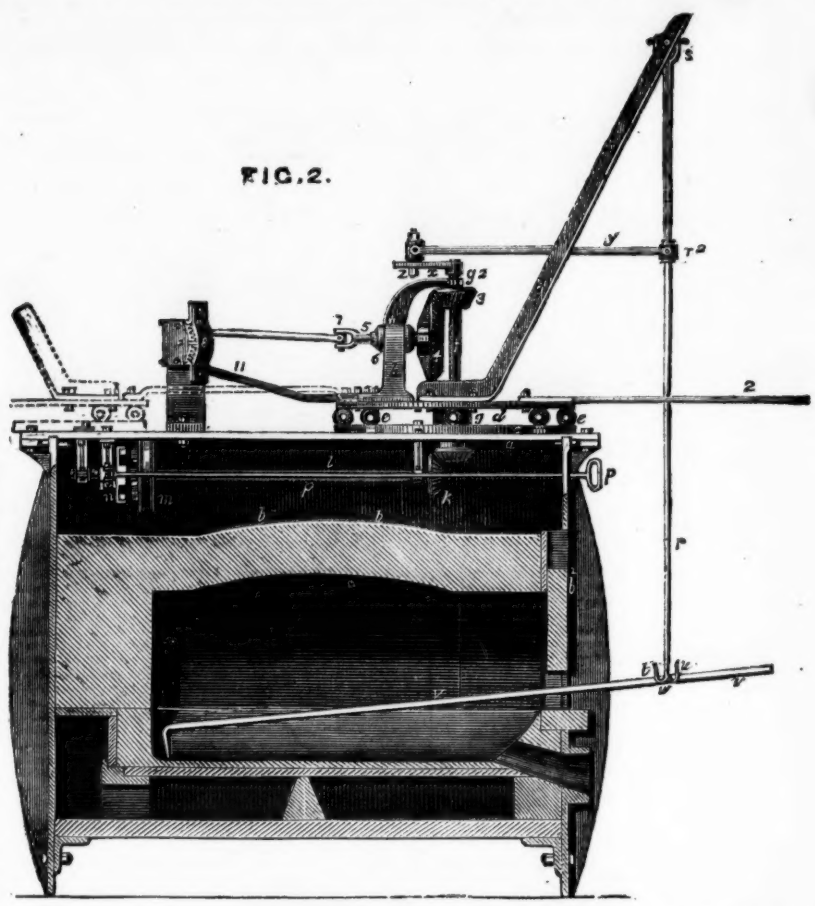
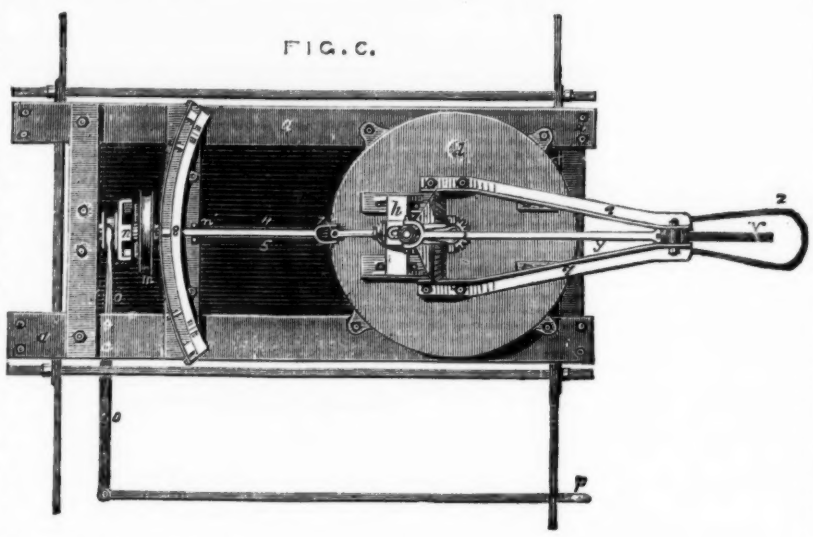


FIG. 2.



In our illustration* Fig. 1 shows a front elevation, Fig. 2 a vertical section, and Fig. 3 a plan of the machine, of which the following is the description:—*c* is a circular bed plate, provided with ears, through which it is fastened to the furnace; *d* is another circular plate, rotating on balls rolling in a grove in *c*, and bearing the jib *q*, to which the puddling rabble is suspended by the hanger *r*. This plate *d* also carries the standard *h*, which supports the main gearing of the machine. The shaft *f* has its lower bearing at *g* in the plate *c*; its upper at *g* 2, in the curved end of the standard *h*; and it also works in a collar or journal on the plate *d*, so that while the plate *d* carries with it in its partial rotation the standard *h*, the proper relative position of the different parts of the machinery attached thereto with the shaft *f*, is nevertheless always maintained. In fact, *f* is both the main driving shaft and a pillar round which the machinery swings in communicating the necessary traversing motion to the rabble. *f* is driven by the bevelled gear *i* and *k*, communicating with the motive power by the shaft *l*. The pulley *m* works loosely on the shaft *l*, and the machine is thrown in and out of gear by the clutch *n* in the usual way. *f* might be connected directly to the shaft of a small rotary engine, or driven by any other means, but when the power for the machine is taken from a line of shafting, the arrangement here shown is the most convenient. *x* is a crank attached to the upper end of *f*, and giving motion to the hanger *r* by the connecting rod *y*. The connecting rod *y* is joined to both the crank *x* and the hanger *r* by universal joints, and as the connection *s* of the hanger with the jib *q* is of the same free character, the motion communicated by the crank to the hanger, and through it to the puddling rabble, though mainly reciprocatory, or from the front to the back of the furnace, is quite complex in its character, and resembles the movement produced by hand. The reciprocatory or back and forth motion of the rabble being thus obtained, it now remains to show the traversing motion from side to side of the furnace, so as to bring the rabble to bear on all parts of the metal, and thoroughly stir it.

FIG. C.



From the shaft *f*, the bevelled gear wheel 3, through the corresponding wheel 4, drives the shaft *5*, on the end of which is a pinion working in the hollow endless rack 8, which is fastened firmly to the framing by which the machine is attached to the furnace. The shaft *5* has its chief support in the bearing 6 (which is, consequently, made of extra length), and it is provided with the universal joint 7, so that its pinion may traverse round the curves at either end of the rack 8. This rack is curved horizontally to an arc, described with the distance from the shaft *f* as a radius, and it has a guide plate, 10, between the upper and lower rows of teeth, whereby the pinion of the shaft 5 is kept constantly in gear. The bar 11 is fastened at one end firmly to the plate *d*, but at the other it is forked and encloses the shaft *5*, so that while the shaft is free to move vertically in traversing the ends of the rack, its lateral motion from side to side, produced by the pinion following the rack, is communicated by the bar 11 to the bed-plate *d*, and thence through the jib *q* and hanger *r* to the rabble. The end of the jib *q*, and consequently the forked hanger *r* carrying the rabble, thus makes a sweep from side to side in front of the furnace, of precisely the same character as the curve of the rack 8; and by making this curve longer or shorter, the rabble can be made to travel to a greater or less extent in the furnace. In practice, it is found unnecessary to vary the curve of the rack, as a length somewhat less than a quarter circle fulfils all the requirements.

It will be seen that the shaft *f*, around which, as before shown, all the movements of the machine are made, does not stand directly over the front of the furnace, and consequently, as the working hole is small, when the jib *q* approaches each extremity of the curve through which it sweeps, the rabble brings up against the sides of the working hole, thus producing a leverage in its operation. At the same time that this leverage occurs—that is, when the jib is at each end of the sweep—the pinion on the shaft 5 is working up or down the curved ends of the rack 8, and as the lateral motion of the shaft, and consequently the partial rotation of the plate *d* and sweep of the jib *q*, is thereby for the time being nearly or quite suspended, during this interval the crank *x* gives the rabble a few back and forth strokes in nearly the same position in the furnace; and as at this time the rabble is working upon the jambs of the furnace, the leverage before mentioned, combined with the repeated reciprocating strokes, and aided by the suppleness of the joints of the rabble, causes it to sweep the jambs completely clean of any particles of metal which would otherwise adhere, and which could not be reached by a rigidly operating tool. The end of the hanger *r* has a double fork, which is used as follows:—When the fettling in the furnace is new, the rabble is worked in the fork *u*. After the fettling is considerably worn, it becomes necessary to increase the length of the stroke of the rabble, which is done by altering the position of the crank pin *z* in its slot in *x*; but as the front of the furnace has no fettling, and is consequently unaltered, it is only desirable to compensate for the wear at the back, and then the rabble is worked in the fork *t*. Thus, while by the increase of the length of stroke, the wear of the back is compensated for, by shifting the rabble forward it is still made to traverse to its original position in the front of the furnace. Besides the machine put up at the Northfield Ironworks, one has been at work at the Rhymney Ironworks, South Wales, and another at the Regent Ironworks, Bilston, for about three years; and both are giving perfect satisfaction. We may add that Mr. Griffiths is now working a double furnace, with two machines, at the Northfield Ironworks. In doing this, he dispenses with one rack for giving the reciprocating motion, which is effected by means of the crank connecting the two tables, as shown in dotted lines in Fig. 2. We understand that these machines are giving thorough satisfaction, upwards of 40 per cent. saving being effected in coal.

* We are indebted to our excellent contemporary, the "Mechanics' Magazine," for the engravings and description of Mr. Griffiths's Puddling Machine.

SILVER MINING IN NEVADA.

ESTIMATED COST AND YIELD—THE BALANCE-SHEET.

In conversation recentl with a prominent Bostonian, while expatiating upon the wonderful metallic wealth of Nevada, and citing as a proof of the fact that within the past year that State had shipped to New York and Boston alone (not counting a hundred places to which shipments were made) over $40,000,000 in bullion or coin, we were abruptly met with the reply—"Why, $40,000,000 are nothing. No less than $17,000,000 have been spent during the year in the item of freight alone, for machinery, &c. The balance of $23,000,000 does not begin to pay for the machinery, &c., which has come to the mines this year." If this statement be correct, it will, at first glance, startle one. A second glance, however, will be re-assuring. What if the facts be as stated? Simply this. When capital is invested in mines, the person investing certainly cannot expect returns within one year of the whole or half of his money. There is risk, of course, more or less in all mining operations. That risk is encountered for the sake of an anticipated yield of a larger percentage on the investment than is offered by any other class of enterprise: 20 or 30 per cent. per annum is, we believe, generally calculated upon, although from lack of judgment at the start, or mismanagement afterwards, either of the trustees or superintendents, it is not always obtained. Suppose, then, that even $100,000,000 have been expended within the past year in the mines of Nevada, the return of $40,000,000 is just 40 per cent. upon the amount invested, or 10 per cent. more than the most sanguine investor should expect. It might be said to this, in reply, that the $40,000,000 did not all return to the same pockets that invested the $100,000,000. Very true; we will admit that, but some of it did; and, furthermore, as we have just remarked, it is well understood that capitalists investing in mines cannot have immediate returns. They must wait until the mines are opened and in working order, the ore reduced, and shipments made, &c., all of which takes time. Thus, the $100,000,000 invested last year must wait until the next, and so on. But if $100,000,000 be invested every year, and the returns for it every year are $40,000,000, any sensible man must perceive that the investments pay tremendously; because, besides these yearly returns, the mining or milling property is improving in value at the rate of $100,000,000 per annum, so that he who puts $100 in last year, will have $140 this; or, in other words, at the same ratio, in two years and a-half from the time of investment, he will have his share, representing $100, besides the $100 in his pocket. What better showing than this is needed? But we do not believe that more than $200,000,000 of capital has been invested in her mines from the time of their discovery until now; and nearly half of this has, probably, been yielded by the mines themselves, making the amount of outside capital expended upon them only $100,000,000. We do not make this statement thoughtlessly. We estimate that there are 300 mills in Nevada, which have cost an average of about $60,000 each, or a total cost of $18,000,000 for all. There are, probably, about 2000 mines, being worked by an average of six miners to each, at (say) $5 per man per diem, or nearly $19,000,000 per annum. In previous years there were not so many, but the average for the past five years, we will say, is $10,000,000. Superintendents' salaries for those years we set down at an average of $1,000,000 per annum, or $5,000,000 in all; cost of timber, tools, repairs of machinery, quicksilver, &c. (say) $5,000,000 per annum at present, or an average of (say) $20,000,000 in all. There is an average of five men employed at each of the 300 mills, at an average of $4 per working day for each man, making $1,878,000 per annum, or averaging the entire five years, a total of (say) $7,500,000. We will recapitulate our estimated total cost of mining in Nevada from 1862 to 1866 inclusive:—

Mills	$18,000,000	
Mill hands	7,500,000	
Superintendents	5,000,000	
Miners	50,000,000	
Material	20,000,000 =	$100,500,000
To this we will add for—		
Other machinery and pumps	$ 5,000,000	
Other occasional hands (say)	2,000,000	
Incidentals (large)	5,000,000	
Litigation (large)	8,000,000 =	20,000,000
Grand total		$120,500,000

But the best engineers in the world, although very close figurers, should add 60 per cent. to their estimates, as human judgment is fallible. And although we have made most liberal ones in the above figures, we are willing, for sake of argument, to do even more,—add over 66 per cent., and call the grand total cost of the Nevada mines and mills to the close of this year $200,000,000. Now, there has been coined at the San Francisco Mint about $100,000,000 silver bullion extracted from the Nevada mines, and we think it but fair to estimate that as much more in the shape of bars has found its way elsewhere—to China, Europe, and other countries—making the total product of the Nevada mines $200,000,000 against $200,000,000 invested, only half of the latter, we repeat, having been supplied by cash capital. In other words, the parties who, from the commencement of 1862 until the present date, have invested $100,000,000 in the silver mines of Nevada, have made these mines furnish $100,000,000 more for expenses, besides returning 20 per cent. per annum, or $100 per cent. in five years upon the amount of actual investment. And this, in spite of the exaggerated estimates we have made against the mines, and in spite of the fact that we have counted the past year's investment, the profits upon which ought not to be looked for until next year. If a man has but $10,000, and puts it in any business, and in five years, from the profits thereon, finds he has $10,000 in his pocket, and his business still going on swimmingly, he may be said to have extraordinary good fortune. That is just what the exaggerated silver mines of Nevada have done for those who put the capital in to start them; and it can be seen from the dividends paid last year, as given in the *San Francisco Mining and Scientific Press* of Dec. 22, 1866, that six mines alone, working 5000, excel by far the above statement, owing to the improvements in the reduction works, in which we are advancing daily, have paid $330,000 per month, or $3,960,000 per annum, an average of 5½ per cent. per month, or 66 per cent. upon the market price of the shares, while three of them, of which we know the capital employed, paid at the rate of 30, 76, and 65 per cent. per month, or 360,780,912 per cent. per annum upon subscribed capital.

THE COPPER MINES OF CHILI AND BOLIVIA.

The whole range of the Andes is known to be filled with precious metals of incalculable wealth. All along the coast, for 4000 miles, are mineral indications visible to the naked eye, and in some places the tourist sails many days past bluffs deeply stained with the deposits of copper. At every port minerals from the interior are exhibited for sale—to induce explorations; and small smelting-works dot the shores from Peru to far south of Valparaiso. The traditions of the Indians, whom the Spaniards found here nearly 400 years ago, were full of accounts of gold and silver mines, and from that time to the present day new discoveries have followed each other with almost fabulous rapidity. It would be impossible to give all the traditions that still exist respecting mines that have once been worked by Indians on a small scale and are now unknown. The authenticated accounts of accidental discoveries of silver by peons, who either parted with their new acquisitions for a trifle or suddenly amassed immense fortunes, would fill volumes. In the coal mines of the South of Chili I saw men working with the pick who once owned portions of the coal district, and many of the copper and silver mines now in operation have labourers employed in them who knew of the existence of the mines long before they were opened. A few luckly discoverers turned their good fortune to account, and from paupers became very wealthy. I know of one instance, in particular, where the owner of a mine was formerly a half-starved peon, glad to get 10 cents a-day, and who now has an annual income of $200,000.

Gold and silver in abundance are found from the Isthmus of Panama to the Straits of Magellan. The silver mines of Peru have long been well known, and the discovery of silver in Chili dates back to a very early period. Gold is found in many parts of this country, and has been worked in some, but not with satisfactory results. It is believed that the extreme southern districts of Chili, now occupied by Indians, has very rich gold mines, as considerable quantities of that metal reach the coast through the hands of traders with the various tribes. Near Valparaiso several attempts have made to get out gold, and one or two parties did tolerably well for a time; but the project was finally abandoned. Immense mines of silver and copper are found in Bolivia and the north of Chili; and further south are rich and extensive coal fields. Mines of cobalt, zinc, lead, &c., have also been discovered, and are being worked successfully. In addition to these mineral riches a portion of the coast yields many tons of saltpetre annually.

The TAMAYA MINES are the largest copper mines in the world, and are an imperishable monument to the energy and ability of their principal owner—Don Jose Tomas Urmeneta. I passed several important mines on my way from Coquimbo to Tamara, and had heard great stories of the extent of this famous place; but I was unprepared for the magnitude of the operations I found going on up above the clouds. I started from the table lands above the Limari valley to climb the Tamaya Mountain. From its base the mule path winds in a zig-zag fashon up among immense volcanic rocks, and along precipices down which a misstep would hurl one to destruction, until it is lost to sight in the mists which hang about the peak. The ascent was slow and tiresome; but once upon the summit, as the sun cleared away the fog banks, a view was revealed never to be forgotten. From the little town clinging to the ledges of the peak the vision extended far up and down the beautiful valley of the Limara, across leagues of table land dotted with clumps of cactus, and over successive mountain ridges to the main cordilleras, white with eternal snow. There are nearly 10,000 persons living on the hill, and from the heights above the figures moving along its sides, dwarfed by distance and comparison with surrounding objects, appeared like pigmies. Strings of packed mules going down laden with copper ore, and coming up with various freights or empty packs, straggled along like ants busy with the discovery of a new supply for their winter store; and the carts down on the Tongoy road seemed to have no more motion than fishing boats when the wind and tide are still. The whole mountain is honeycombed with shafts and galleries, and its exterior covered with heaps of blue ores too poor for transportation. In some of these piles there are hundreds of thousands of dollars, but at present it is too expensive to work such a low class of ores, and these are left for future operations, when the railroad is opened. The mountain is 4200 feet high. Five hundred feet below the summit, on the eastern side, the copper makes its appearance on the surface, the lode running north and south, and dipping to the west at an angle of 52°, with an average thickness of 7 feet. In many places the lode is 21 feet thick, and contains 50 per cent. of pure copper. The hill is divided among various individuals, who are mining with different results, according to the extent of their machinery and manner of working. Mr. Urmeneta commenced his mining operations at Tamaya in 1834, when he took up two claims on copper lodes. Other parties were also working in the same hill at that time, and, with a forethought which everyone ridiculed at the time, Mr. Urmeneta commenced sinking a shaft at the back of the other miners. As the lode dips at an angle of 52°, his perpendicular shaft finally struck the metal behind the claims of his competitors, thus cutting them off from further progress, and giving him controul of the whole mine beyond a certain point. This shaft was sunk through hard porphyry, and took ten years in its accomplishment, exhausting Mr. Urmeneta's fortune of several hundred thousand dollars, and heavily involving him in debt. As soon as he reached the copper, however, he commenced taking out immense quantities of very rich ore, and since that period his mine has annually furnished about 180,000 quintals of ore, of 25 per cent. pure copper. He built a cart road up to the mine at an expense of $80,000, and erected steam-engines, workshops, and dwelling houses, where it seemed impossible for a foothold to be obtained. Now there is a busy little town, a handsome church erected by Mr. Green, and almost every convenience for comfortable living. The magnitude of this work can only be appreciated by those who have travelled across the sandy desert between the coast and Tamaya, climbed the barren mountain side, and seen the precipices over which the ponderous machinery and other paraphernalia of mining have been borne. The enterprise of Mr. Urmeneta had not been confined to money-making alone, but has built fine houses for his managers and assistants, in which

THE SIXTEENTH ANNUAL STATISTICS OF THE MINING INTEREST.

BY WILLIAM HENRY CUELL, ESQ.

TABULAR STATEMENTS, CONTAINING RETURNS OF ORE, &c., FROM DIVIDEND-PAYING MINES FOR THE PAST YEAR (1866).

CORNISH AND DEVON MINES.

Shares.	Names of Mines.	Amount Paid.	Dividend per share.	Total Amount.	Metal.	Parish.	Purser or Secretary.	Address.	System.	Meetings when held.	Copper.	Tin.	Lead.	Total Amount of Money.	Lease granted.	Dues.
											Tons.	Tons.	Tons.	£. s. d.		
200	Botallack	£91 5 0	£5 0 0	£1,000 0 0	Tin and copper	St. Just	S. H. James	Penzance	Cost-book	Three months	464	343	—	22,004 14 5		{1-18 / {24**
4000	Brookwood	1 11 0							ditto							
916	Cargoll	15 10 0	1 0 0	916 0 0	Silver-lead	Newlyn	E. Michell	Truro	ditto	Three months	—	—	8830*l.*	10,825 19 10*		
1024	Devon Great Consols	1 0 0	43 0 0	44,032 0 0	Copper	Tavistock	A. Allen	Gresham House	Joint-stock	Two months	22,681	—	—	98,144 3 0	finish 1886	1-12
358	Dolcoath	128 0 0	11 0 0	3,938 0 0	Tin and copper	Camborne	C. Thomas	Camborne	Cost-book	ditto	635	892	—	48,275 1 7†	1849 .. 21	1-24
6144	East Caradon	2 14 6	0 7 6	2,304 0 0	Tin and copper	Linkinhorne	C. R. Norton	Salisbury	ditto	Three months				15,936 7 2	1863 .. 21	1-18
1906	East Lovell	3 9 0	0 7 6	715 0 0	Tin	Helston	S. O. Rogers	Helston	ditto							
128	East Pool	5 0 0	17 10 0	2,240 0 0	Copper and tin	Illogan	W. Prisk	Camborne	ditto	Two months	1776	365	—	21,969 12 5‡		1-16
5000	East Rosewarne	2 15 0	1 6 0	375 0 0	Copper	Gwinear	E. King	22, Austinfriars, E.C.	ditto		859	—	—	5,327 14 6		1-18
5000	Frank Mills	3 18 0	0 12 0	3,000 0 0	Lead	Christow	C. Wescomb	Exeter	ditto		—	—	796	11,548 8 10		1-13
5908	Great Wheal Vor	40 0 0	2 1 0	12,111 8 0	Tin	Breage	G. Noakes, man. dir.	Gresham House	ditto	Three months	—	845	—	43,816 9 10		1-18
1024	Herodsfoot	8 10 0	4 15 0	4,864 0 0	Silver-lead	Lanreath	T. Trevillion	Liskeard	ditto	Four months	—	—	486	10,238 12 5	21	1-15
6000	Hingston Down	5 10 6	0 5 0	1,500 0 0	Copper	Calstock	T. B. Laws	22, Great St. Helens, E.C.	ditto		3498	—	—	12,996 9 0	1867 .. 21	1-20
9000	Marke Valley	4 10 0	0 6 6	2,925 0 0	Copper	Linkinhorne	J. Harding	Salisbury	ditto	Three months	5149	—	—	17,675 14 8	1863 .. 21	1-18
1120	Providence	10 6 7	2 10 0	2,800 0 0	Tin	Lelant	S. Higgs	Penzance	ditto	ditto	327*l.* 10s.	1928‡†	—	19,317 0 10		1-22
512	South Caradon	1 5 0	36 0 0	18,432 0 0	Copper	St. Cleer	T. Kittow	Liskeard	ditto	Two months	5800	—	—	48,466 19 3		1-15
6000	Tincroft	9 0 0	1 5 0	7,500 0 0	Tin and copper	Illogan	W. Teague	Camborne	ditto	Three months	290	464	—	23,640 14 8	21	
3000	West Chiverton	10 0 0	7 5 0	21,750 0 0	Lead	Perranzabuloe	R. Clogg	Liskeard	ditto	ditto	—	—	3316	46,363 9 1	1855 .. 21	1-15
400	West Seton	107 0 0	19 0 0	7,600 0 0	Copper	Camborne	B. Matthews	St. Day	ditto	Two months	5889	—	—	29,648 11 6		
512	Wheal Basset	5 2 6	6 10 0	3,328 0 0	Tin and copper	Illogan	F. W. Dabb	Redruth	ditto	ditto	2136	167	—	20,591 5 7	1850 .. 21	15-24
4295	Wh. Kitty (St. Ag.)	5 4 6	0 4 0	859 0 0	Tin and copper	St. Agnes	E. King	22, Austinfriars, E.C.	ditto	Three months	250*l.*	1002‡†	—	10,270 17 4		1-22
1024	Wheal Friendship	20 0 0	1 10 0	1,536 0 0	Copper	Tavistock	J. Taylor and Sons	6, Queen-street-place, E.C	ditto	ditto	2206	—	—	15,268 12 10§		
396	Wheal Seton	58 10 0	19 0 0	7,524 0 0	Copper	Camborne	H. Tilly	Falmouth	ditto	Two months	24,279*l.*	1908*l.*	—	26,325 8 8‖		1-15
1040	Wheal Trelawny	5 10 0	1 7 6	1,430 0 0	Silver-lead	Menheniot	W. J. Lavington	20, St. Helen's-place	ditto	Three months						
1024	Wheal Mary Ann	8 0 0	0 10 0	512 0 0	Silver-lead	Menheniot	P. Clymo	Liskeard	ditto		—	—	872½	18,581 12 3¶		1-18
2000	Wheal Rose	—	0 10 0	1,000 0 0	Tin and copper	St. Agnes	H. Michell	Scorrier	ditto		9499½*l.*	—	1363½*l.*	9,636 5 1		1-18

* This amount includes 1921*l.* 13s. 1d. for blende and 74*l.* 12s. 3d. for mundic.
† This amount includes 112*l.* 17s. 6d. for arsenic.
‡ This amount includes sale of 213 tons of arsenic.
§ This amount includes sale of 300 tons 11 cwts. of mundic.
‖ This amount includes 137*l.* 13s. 6d. for arsenic.
¶ This amount is up to the end of Sept., 1866.
** 1-18th for copper, 1-24th for tin.
†† 1-15th for copper, 1-24th for tin.

WELSH MINES, &c.

1000	Bronfloyd	£12 0 0	£1 2 0	£1,100 0 0	Lead	Llanbadurn Fawr	J. B. Balcombe	Aberystwith	Limited 15*l.*		23	—	332	£4,477 0 0	1866 .. 30	1-14
867	Cwm Erfin	7 0 0	4 0 0	3,468 0 0	Lead	Cardigan	J. Taylor and Sons	6, Queen-street-place, E.C	Cost-book		—	—	752	12,161 18 8		
128	Cwmystwith	60 0 0	30 0 0	3,840 0 0	Lead	Cardigan	J. Taylor and Sons	6, Queen-street-place, E.C	ditto		—	—	1081	13,792 9 9		
300	East Darren	32 0 0	14 0 0	4,200 0 0	Lead	Cardigan	J. Taylor and Sons	6, Queen-street-place, E.C	ditto		—*	—	850	13,589 9 9		
400	Lisburne	18 15 0	22 0 0	8,800 0 0	Lead	Cardigan	J. Taylor and Sons	6, Queen-street-place, E.C	ditto	Two months	—	—	2973	38,933 10 0		
1800	Minera	25 0 0	15 10 0	27,900 0 0	Lead	Wrexham	J. Frazer	Wrexham	Joint-stock	Three months	—	—	4461	57,593 12 6*		1-12 16‡
2000	Minera Boundary	1 0 0	0 3 0	450 0 0	Lead	Minera	C. H. Hinks	Wrexham	Limited			—				
200	Parys Mines	50 0 0	5 0 0	1,000 0 0	Copper	Anglesey	J. Taylor and Sons	6, Queen-street-place, E.C	Joint-stock	Four months	4084	—	—	18,795 18 1†		
6000	South Darren	3 6 6	0 5 6	1,650 0 0	Lead and copper	Cardigan	J. H. Murchison	Austinfriars	Limited		160	—	310	6,804 7 10		1-13

* This amount includes sale of 2863 tons of blende for 12,311*l.* 12s. 6d. † This includes sale of 271 tons 2 cwts. 2 qrs. copper precipitate for 2358*l.* 0s. 7d. ‡ 1-12th on lead, 1-10th on blende.

CUMBERLAND, ISLE OF MAN, IRELAND, &c.

280	Derwent	£300 0 0	£7 10 0	£2,100 0 0	Lead	Durham	J. Taylor and Sons	6, Queen-street-place, E.C	Cost-book		—	—	1419	£28,709 12 4		
6400	Cashwell	2 10 0			Lead											
1500	Alderley Edge	10 0 0			Copper	Cheshire										
2800	Foxdale	25 0 0	2 0 0	5,600 0 0	Lead	Isle of Man	J. Dixon	Chester	Limited		—		1646	33,460 6 3		
15000	Great Laxey	4 0 0	2 0 0	30,000 0 0	Lead	Isle of Man	H. Thompson	Sherborne-lane, E.C.	ditto	Six months						
17000	Wicklow	2 10 0	1 7 0	27,200 0 0	Copper	Wicklow	W. S. Kildahl	113, Grafton-st., Dublin								
20000	Min. Co. of Ireland	7 0 0	0 13 4	6,666 2 0	Copper, lead, coal	Ireland	R. Heron	Low.OrmondQuay,Dublin			5709	—	1555			

are found elegant furniture and almost every modern improvement. Flowers blossom on the rocks, nourished with soil brought from the valleys miles below, and the weary traveller to the mine unexpectedly finds at its entrance a delightful abiding place—an oasis in a desert.

The SAN JOSE MINE, adjoining this one, and next to it in importance, is under the direction of Mr. Waring, also an American. The railroad in process of construction from Tongoy to the mines overcomes obstacles never before successfully met in railroad engineering, with the exception, perhaps, of the Mont Cenis road, in Europe. The grade on this road is 5 per cent., or nearly 300 ft. to the mile, and the curves are of 180 ft. radius. It climbs up along the mountain side in places so steep that the workmen cannot go outside the excavation they are working, and where immense masses of overhanging rock are to be removed without endangering mining establishments above. The engineer, Mr. Barry, has already achieved a reputation in South America, and when this line is opened, if it works as it is now confidently expected, he will stand among the boldest pioneers of railroad engineering. From the table land below Tamaya a branch road will be run up through the Limaria valley to Ovalle, and, probably, in a few years to rich mines recently discovered some distance further in the interior. There are hundreds of mines yet to be opened in Chili, which are at present too remote for profitable working.

COPPER EXPORTATIONS OF CHILI AND BOLIVIA.—The following statistics show the amount of copper exported from Chile and Bolivia for the quarter ending June 30, 1866. This amount is much less than that of previous years, owing to the Spanish difficulties, which have sadly interfered with all branches of business on the coast. Copper exportations are now, however, on the increase, and promise to soon exceed that of seasons before. A considerable amount of new mining machinery is now on the way here from the United States, and as the opening of numerous additional mines is only a question of time, there is little doubt that in a few years the supply of copper from South America will be more than doubled. Railroads are needed to promote this end, and a number of lines are now under contemplation. In some parts of Chili and Bolivia pure copper is found resembling that of the Lake Superior mines, and in other places in a form like fine sand. The latter class is called barilla, and is found on or near the surface of the ground, but so far in the interior that pack mules cannot be used profitably in transporting it across the deserts which intervene between the copper and the coast.

Copper exports from Chili for the quarter ending June 30, 1866 :—

	Ores, &c.	Fine copper.
To England	Quintals 339,344	182,612
To France	—	18,011
To United States	42,440	15,000
To Germany	—	1,286
Exports from Bolivia—to England	380,049	191,397

This makes a total of copper exportation from the two Republics, for the quarter, of 441,786 quintals of ores, &c., and 225,694 quintals of fine copper, a decrease from the amount for the same quarter of 1865 of 91,818 quintals of ores, &c., and 71,022 quintals of fine copper.

NEW TUNNELS.—Three new tunnels are being run into the southern basin of the mountain, the second one 600 ft. above the first, and the third 300 ft. still higher up. These are far below the present entrance to the mine, and when complete will enable the ores to be taken out on cars at the bottom, instead of hoisting them hundreds of feet to the opening now in use. One tunnel will be a mile and the other a mile and a half in length, extending most of the distance along the copper vein. The principal advantages to be derived from these tunnels are that they will not only facilitate the taking out of copper in the lode above them, but they will form new levels, from which to go down hundreds of feet still further in the copper with the same ease that the higher portions of the lode are worked from the first upper level, opened 30 years ago. The railroad, now rapidly approaching completion, will pass near the mouth of these tunnels, at which point furnaces are to be erected for smelting the poorer class of ores, of which there are now millions of dollars worth heaped upon the side of the mountain, near the entrances to the several mines. The riches to be taken out from the mine hereafter can scarcely be computed. It must be remembered that the copper lode runs through the hill like a slice of ham in a sandwich; that it averages 7 ft. thick, and 25 per cent. of pure copper; but that, as it rests like a steep roof, no one can tell to what depth it may extend. Most of the principal men connected with the working of this mine are Americans. Mr. Green has been engaged 13 years in developing it, and as manager has under his control about 1000 men. The chief engineer is a young Baltimorean, Mr. J. G. Heisler, and Mr. S. Fulton, another Baltimorean, has charge of the three tunnels being run in at the southern side of the hill.

RAILWAYS IN AND TO INDIA.—There is no man who, from first to last, has done more good work for the promotion of railway communication in India than Mr. W. P. Andrew. From the time when, more than 20 years ago, he wrote a remarkable pamphlet, far in advance of the times, under the modest *nom de guerre* of an "Old Indian Post-Master," up to the present day, he has laboured most assiduously, and has devoted no common energy and ability to the furtherance of this great object. On the general subject of Indian railways, or any particular points connected with it, no man is listened to with more respect. We were glad, therefore, to see him the other day coming frankly and honestly forward to vindicate in the columns of the *Times* the Indian Government with respect to the good faith which it had always observed in the matter of its guarantees. "I have been a party to no less than four contracts with the Secretary of State for India in Council conferring the advantages of the guarantee of the Government of India on the several undertakings with which I am connected, and in no instance has there been for a moment the slightest cavil as to the amount of interest due from Government, or a day's delay in the payment of the amount. Even during the height of the Mutiny, the good faith and punctuality for which the Government of India has ever been distinguished were as manifest as in ordinary times." This is no more than ought to be said about the good faith of the Indian Government, but it is well that it should be said on such high authority. After this, Mr. W. P. Andrew goes on to explain in a very lucid manner the real character of Government guarantees in India, and the precise powers which they confer on the Government granting them. On this the *Times* observes that "the evil incidental to Indian guarantees lies in the readiness of the Indian Government to grant them. The moment any of the 5 per cent. enterprises creep up above par a fresh supply is threatened, and thus the previous investors never see their stocks attain a proper position in the market. But for this constant swamping of any premium to which they may reach, they would probably before this have acquired a popularity in India that might have tempted native capital to flow into them, a result which has thus far been remarkably absent. Certainly, if the debt is, as Mr. Andrews suggests, to be looked upon as almost equally sacred with the liability to the English fundholder, it would be well that Parliament should at once assume a greater supervision over it, since in that case, while there is the present jealousy of affording the slightest aid to English lines, we may assume there would also be some disposition to restrain the extension of our credit commitments for a territory so distant. But the fact is that there is not at present any readiness on the part of the Indian Government to guarantee any experiments of the kind, and that, as far as we understand the matter, Parliament has really nothing to do with it. If an imperial guarantee were given, of course parliamentary supervision would be called for; but, as it is, the supervision of the Secretary of State for India in Council, which is vigilantly exercised, is all that is required. Turning to another and, perhaps, more important subject, we may say that we observe with much satisfaction that Mr. Andrew is again moving—and he is one of those men who seldom move in such cases without eventual success—for the promotion of the great national scheme of the Euphrates Valley Railway. This is a project the immense advantages of which far transcend either the difficulty or cost of execution. To open out a new and more expeditious "overland" route to India would seem to be a gigantic undertaking; but the impediments offered to it are small, and the facilities, on the other hand, such as to encourage every reasonable expectation of success in all the different aspects in which it can be regarded—political, military, commercial, and financial. On the present occasion, we merely glance at this important subject; but it is one which we shall keep steadily before us, and to which we shall return from time to time, as the scheme appears to develope itself. It cannot be in better hands. Napoleon said that he had faith only in successful men. Mr. Andrew has been eminently successful. The schemes which he has worked out have prospered; and this, the greatest scheme of all to which he has directed his energies, will, we believe, be eventually accomplished.

HINTS TO EMIGRANTS—No. IX.

BY CHARLES S. RICHARDSON.

Of birds there is the wild pigeon, partridge, pheasant, wild duck, widgeon, wild turkey, snipe, and woodcock; the latter is rare. The partridge is small, being about the size of a dove; they are in some places called quails: they go in covies, and their habits appear about the same as those in England; they are generally very plentiful. The pheasant (so called here) is not a pheasant at all; it is properly the "ruffed grouse," or the *bonasa umbrellus* of the naturalist. I am doubtful if a true pheasant, in its native state, can be found in America; I certainly have never seen one, but the bird called by this name here is about the size of a half-grown fowl, and the most delicious of all game. I think it is a great pity this beautiful bird is not preserved, but in the absence of game laws, or some other legal restrictions, I do not see how it can be done. Of carnivorous birds and reptiles, we have various kinds of hawks, the plaintive whippo-will, black eagles, owls, buzzards, storks, herons, and kingfishers. Of reptiles, there is the black snake, garter snake, copperheads, brown water snake, mocsins, the rattlesnake, and a few small vipers: none but the copperhead, the mocsin, and rattlesnake are considered venomous, but they are all fast disappearing before the onward march of civilisation, and in a very few years hence the original denizens of the forest will cease to have an existence.

I have now shown you the chief attractions of a life in the forest settlements. Lonely and sombre as it may appear, it has a peculiar charm; there is a fascination about it I cannot find words to describe. Many persons, after living here a few years, have little inclination to leave it. There is an absence of the conventionalities of society, a kind of independent freedom, which, although not expressed, is felt and enjoyed by all. You may here have at certain leisure seasons opportunities of enjoying a little of—

"A life in the forest glade,
Where the red deer boundeth free,"

without being compelled to endure the irksomeness of its habitual solitude, for a day's ride will bring you to the mountain districts, where the forest may yet be seen in its primitive grandeur. With rifle, fishing rod, or spear-gig the boys have always a source of athletic amusements, while the girls with their spinning wheels, husking and quilting parties at home, are equally amused. Thus, useful labour becomes a pleasure, and in the prosecution of pleasure you derive a profit. One of the greatest drawbacks to living far out of the villages is the want of schools, and one hitherto severely felt by the settlers. I am happy to say, however, that this defect is about to be remedied, especially in the central counties, and we hope in less than four years no school-house will be more than three miles distant from any farm. And now, my friends, in bringing this first section of my subject to a close, let me show you how much good we may all do by religious and educational association. You must be aware that in settling up a country like this, which is all "hill and dale," it is impossible for the farms or homesteads to be contiguous, for the very nature of the ground prohibits such approximation. Central villages or hamlets, three or four miles apart, is as much as can be expected under such circumstances. Now it is certain only the larger children can go to school at all; the younger ones must be without education until they are old enough to walk such a distance. To obviate this deficiency to a certain extent, and at the same time preventing the older ones from getting into mischief on Sundays, and thus inculcating bad habits, half-a-dozen families can unite, build a log house, and establish a Sabbath school. What better amusement can be found, what greater influence can be brought into play to soften and smooth the vexations and asperities of the past week's toil and care, than in teaching or hearing these little infantile ideas recite their first lessons of love and duty. How often have I been melted to tears while passing one of these "God's cabins" of the wilderness, in hearing those little sunny-bronzed cherubs of the settlers singing in their peculiar mixed vernacular—

"Dere is a happy land,
Fa, fa away."

What thrilling emotions overcome the soul when we contemplate the future of these little ones, when we know how much good we can do if we only try; how ennobling, and yet how small and trifling the energy required to effect so much good. I, therefore, earnestly advise, and say that, "if only two or three are gathered together," let your first efforts, immediately after you are settled, be directed towards the moral training of the young children; your reward is certain, not only in the inestimable advantages you render the society around you, of which you are a participator, not only in the humble contribution you make towards the intellectual improvement of the rising generation, but in that "sure and certain hope," that solace in our old age which we all desire, and which all good men are conscious of when they are about to close a well-spent life. To those of my friends who have had patience enough to wade through the whole of these desultory papers, I would say, if the subject is considered useful or entertaining, I have a fund of information, derived from experience, relating to several of the States and Canada. I have here only roughly outlined a picture of emigrant life in West Virginia; it admits of variation under different circumstances and location—the trade or calling of the individual, his prior position in society and contemplated object, his temperament, disposition, and moral aptitude; but the road to fortune or competence is about the same in all cases, for it is, either bodily or mental, work, work, toil, toil. Nevertheless, if such is looked upon as a pleasure, arduous though it may be, with good health and a good heart, the ultimatum is a certainty, for his efforts will be crowned with success.—*Pine-street, New York.*

SLATE—GEOLOGICALLY AND OTHERWISE CONSIDERED.—The formation of slate was probably the result of a purely mechanical operation. During the eocene existence of our earth, we learn that it was without "form or comeliness." Hence, it is supposed the elements were in a conglomerate state, while the particles of matter were constantly impinging by the ebb and flow of the great thermal ocean by which the globe was enveloped; and with this intense heat, in connection with chemical and electrical action operating on the gneiss, whose ingredients were held in solution during a succession of ages, was precipitated in laminated layers, thus forming the immense slate beds, the use and value of which are just beginning to be appreciated in the United States. Having geologically considered the formation of slate, we shall point out its inferior as well as its superior qualities, so that those who desire to use slate may know how to select the colour and quality adapted to their wants. Slate suitable for "school slates," as well as that which requires scouring, planing, rubbing, and carving, for commercial purposes, should be soft and of a uniform texture, free from lime, grit, and flints; while the harder qualities—that is, of the clay slate—are better suited to the manufacture of roofing slate. Although the slate formations in this country are very extensive, yet but comparatively small quantities have been found sufficiently pure to rank as strictly first quality; for slate varies exceedingly in its chemical constitution, as might naturally be expected, since it is a compound mixture, consisting of very minute particles of quartz, felspar, and mica, to which are occasionally added scales of talc and portions of carbonaceous matter, with oxides, sulphurets, and pyrites, on which ever-varying preponderance of these ingredients the colour and quality of slate entirely depend. The slate that contains the greatest proportion of silex and alumina to the other incident constituents will prove the best, not only as to quality but permanency of colour, and may be found near Hydeville, Vermont, as well as in one or more of the Pennsylvania quarries. The colour of the Pennsylvania slates, which is of a dark blue, is owing to the presence of crabon. A light purple is the result of a combination of iron and copper. A tincture of lime and iron gives a greyish brown, and magnesia a green; while the incorporation of copper, without the presence of iron or lime, gives an unfading dark purple. Hence, roofing slate containing these fading impurities will soon be detected by the slates assuming such a great discordance of colours as to utterly destroy that beauty and harmony which can only be secured by using "unfading slates."—"SILEX," in *American Journal of Mining.*

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